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ABSTRACT

In recent research on the computer there is an optimistic outlook, i.e., the promise of this new tool in fostering learning and literacy. But an examination of 33 studies (experimental, case, and ethnographic) also indicates deficiencies in computers and writing research. Two drawbacks seem to be the lack of rigor in both quantitative and qualitative investigations and the danger of dismissing previous research before the field has a chance to define and establish itself. Few studies have examined how computers affect and interact with the cultural context or learning environment in which they are used--either for writing or for instruction. Many studies lacked detail in the context in which the research was conducted or failed to include and describe the word processing package. In an attempt to add to the cumulative knowledge in computers and composition researchers should: (1) develop qualitative studies that often can provide rich description, revealing patterns, and themes that can then be studied through quantitative methods; (2) establish studies that examine a range of variables; (3) organize longitudinal studies with writers and word processing; (4) formulate studies that look into writers who use word processing all the time for composing; (5) examine, for instructional context, how computers interact with the activities of the classroom; and (6) investigate studies that record writers' generation and revision of texts. (Two tables are included and 50 references are appended.) (MS)

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RESEARCH IN COMPUTERS AND WRITING:

FINDINGS AND IMPLICATIONS

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In extolling the educational worth of computers in general, Seymour Papert some years ago stated, "[Computers] will change work and play, but the most important change will not come through what the computers can do for us, but through their effect on how people learn." (1981, p. 99) In the same article, he went on to note that the "computer presence . . . . will perhaps even reverse the order [of learning language skills] in that mastery of writing may develop faster once it starts, than mastery of speech." (p. 100) Papert's predictions are noteworthy not because we, as writing teachers and researchers, necessarily believe them--but rather because of the optimism they reflected in 1981 for the promise of this strange new tool in fostering learning and literacy.

And this enthusiasm was not restricted to mathematicians or to others whom we commonly associate with technology. In his 1984 foreward to *Computers and Composing*, Edward P. J. Corbett argued that English teachers must rise to the challenges of electronic communication and that "[a]fter only a week of hands-on experience with this wondrous machine, [he] acquired a keen sense of its potency and its potential . . . . " (p. xii). Our students too told us of the wonders of word processing, and our

own writing on the machine suggested the credibility of their opinions. Thus, those of us who taught with computers and also studied the influence of computers on writers and their products approached our research with high expectations. It is no surprise, then, that in our ebullience, we sometimes expected so much of computers and word processing that our research became "technocentric," a term Papert (1987) uses in a recent article in the *Educational Researcher*.

According to Papert, technocentrism is analogous to Piaget's notion of egocentrism. That is, just as a child has difficulty, he argues, in moving beyond the self in comprehending phenomena so those of us caught up in technocentrism have difficulty in decentralizing the computer in our research. Furthermore, he maintains that technocentrism manifests itself in such research questions as "What is THE effect of THE computer on cognitive development?" (p. 23) Humanists, he goes on to assert, are especially susceptible to technocentrism because of the awe and misunderstanding with which we often approach technology. Thus, these misconceptions are likely to lead us to ask such questions as "What is THE effect of THE computer on the writing process?"

Those interested in computers and writing will recognize some validity in Papert's claim, but Papert's own early writings also suggest this same sort of technocentric emphasis on the power of computers to effect change in the ways students learn and write. Members of our own profession have also lodged other complaints about deficiencies in computers and writing research (see Thiesmeyer, this volume), criticizing the lack of rigor in

both quantitative and qualitative investigations. Still yet another danger, however, lies in dismissing previous research before the field has a chance to define and establish itself. Instead, we best refine our hypotheses and methodologies by building upon that which we already have learned.

I will return to Papert's notion of technocentrism and its application to our field of research, but first let me review the kinds of inquiry into computers and composition with which we, as a profession, have been engaged for the past several years. The purpose of this article is not to criticize early studies but rather to sort out what we have learned so that new research can add to an accumulating knowledge-base in assessing the value of word processing for writing and for teaching writing. After presenting an overview of 33 studies conducted since 1981, this chapter discusses some directions that researchers might profitably pursue in the future.

Research into computers and composition over the past six years has concentrated on the effects of word processing on students and other writers, on the processes in which writers engage as they write, and on the products writers create with the aid of computers. Few studies have examined how computers affect and interact with the cultural context or learning environment in which they are used--either for writing or for instruction. Many of the investigations dealing with the school setting, however, both acknowledge and stress that change or lack of change in writers' behavior or products cannot be attributed to computers alone--that the writing instruction students receive is also

important in shaping the influence of computers. And several investigations are concerned not with instruction but rather how computers facilitate the composing of experienced and sometimes professional writers.

Selection Criteria

Several criteria were applied in choosing the 33 studies reported here. First, the studies are either published pieces, national conference papers from 1981 onwards, or dissertations listed in *Dissertations Abstracts International* for the same period of time. In the case of dissertations, abstracts were used to identify studies before the full text was subsequently examined. Second, each of the studies regards computers as tools for writing rather than as intact instructional delivery systems. Although heuristic and invention software, text analysis programs, and drill and practice courseware might well affect writers and their products, they were not the focus of this overview. Third, the research reported here includes more than students' or other writers' attitudes toward computers after they worked with them for a given period of time. The studies also employed a research methodology other than survey techniques. Although surveys can provide significant information on writers' reported use of word processing and its perceived influence on writing habits and processes, these 33 studies all relied on additional methods of inquiry. When surveys were included, the researchers' aim was to corroborate findings from other methods of study and observation. And, fourth, research that one might label as informal inquiries or that didn't specify a particular

methodology were not selected for this review. In an earlier article (see Hawisher, 1986), I included such exploratory research because of its potential to lead to more systematic study. The proliferation of studies in word processing and writing--at least 12 in the past year--prevented the inclusion of these preliminary inquiries here.

Research in Word Processing and Writing

Studies in word processing over the past several years are classified into two categories: those that employ quantitative methods of inquiry and those that rely on qualitative techniques. (See Tables 1 and 2.) The qualitative studies can be divided further into case studies and ethnographies. When the categories the researchers themselves gave to their studies are used to classify the 33 reviewed here, 18 may be considered experimental (or quantitative) and 15 naturalistic (or qualitative).[1] Eleven of the qualitative investigations are case studies and four are ethnographies.

INSERT TABLES 1 AND 2 ABOUT HERE

If we look at the quantitative and qualitative research in regard to the characteristics of the sample, the design and

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[1] Although I use the term *experimental* generically, with the exception of the Pivarnik (1985), Cirello (1985), Wooley (1985), Wetzel (1985), Hawisher (1986), and Kaplan (1986) studies, the investigations reported here are *quasi-experimental*, that is, the subjects were not randomly assigned to treatments.

context for the study, and the results of the study, some interesting patterns emerge. I'll first examine the experimental research and then discuss the case studies and ethnographies.

Experimental Studies

By far the most common population of interest for the quantitative studies was students of some sort. Of the 18 experimental studies (see Table 1), four examined samples of undergraduate college students, two high school students, three junior high, and six elementary students. Only three of the experimental studies reviewed here looked at writers outside the school context--two studies conducted by Christina Haas and John Hayes with the same sample of 15 faculty and staff and John Gould's investigation of 10 IBM researchers. When we look at context, then, we can say that the majority of the quantitative studies focused on the effects of word processing used in school to teach writing rather than to facilitate writing outside the academic setting.

Another interesting pattern emerges when we continue considering context: of the quantitative studies conducted in the school setting, almost all described the instruction as process-oriented. When we examine the description of what is meant by process-oriented, the term is used to denote writing as an activity in which writers engage in prewriting, composing, and revising of multiple drafts. The description also often includes "conferencing," that is, teacher and student conferring between drafts and/or peer evaluation. Although two of the quantitative studies explicitly excluded peer evaluation from the research

design for fear that it would confound the influence of word processing, all regarded peer interaction as integral to a process-based environment. It would seem, then, that most of these studies were not only sensitive to the role instruction plays in combination with word processing but also tried actively to create a setting in which the pedagogy was grounded in theory and research.

All but one experimental study also tried to control for the potentially biasing effects of teacher differences. This attempt usually took the form of having the same instructor, often the researcher, teach all treatment groups. If the researcher were biased toward one of the treatments, however, this method exerts little control except in the case where the treatments were randomly assigned within the same class, thus ensuring the same instruction for both groups. One of the criteria George Hillocks (1986) stipulated as a requirement for the studies in his meta-analysis of empirical research in writing from 1963 to 1982 was that there be twice as many instructors as treatments. To control for teacher bias, in other words, the computer studies that focused on treatments with and without computers needed four instructors to teach, with the two treatments counterbalanced then over four classes. When we apply either the criterion of one instructor for all treatments or twice as many instructors as treatments to the 13 experimental studies reported here with a treatment design in an instructional setting (e.g., Cirello, 1986; Coulter, 1986; Daiute, 1986; Duling, 1985; Hawisher, 1986; Kaplan, 1986; Levin et al., 1985; Miller, 1984; Pivarnik, 1985;

Sommers, 1986; Wetzel, 1985; Wooley, 1985; and King, Birnbaum & Wageman, 1984), only Miller's study does not meet these requirements. Miller randomly selected 28 students from a larger group taught by two teachers, but it is not clear how many students were taught by one or the other teacher. The remaining twelve studies all attempted to control for teacher differences.

For the most part, then, these experimental studies explored how word processing in combination with a process-oriented teaching methodology influenced writers--their processes and products. Two of the studies (e.g., Duling, 1985; Miller, 1984) looked at the word processor only as a revision tool. That is, the students produced all first drafts by hand and only revised at a computer. Harris's (1985) case study of college students is similar in that students could produce their first drafts in any fashion they pleased; they were required only to revise with word processing. Increasingly, however, studies in word processing seem to be moving away from exclusive emphasis on revision and instead examine how writers *compose* with computers, that is, how they plan, generate, and evaluate text either on-screen or in some combination with hard-copy.

This new emphasis on the interaction of computers with composing processes other than revision is especially true of an investigation (e.g., Haas, 1986) outside the instructional context with writers who are experienced at word processing rather than novices who are learning a system. In fact, if we look at the earliest study among the 18, John Gould's pioneering investigation of ten IBM researchers, and one of the most recent,

Christina Haas's study of 15 faculty and staff, we can trace the direction in which research in computers and writing seems to be moving and follow the rapid advancements which have been made in technology. The first part of Haas's study, which she conducted with John Hayes (see Haas & Hayes, 1986b), is actually a replication of Gould's early study. The second part, however, departs from Gould's methods. Whereas Gould in 1981 used videotapes to look at writers composing, planning, and rereading with a line editor and examined the variables of time, length, quality, and frequency of revision, Haas in 1986 used think-aloud protocols to examine how the processes of planning and rereading interact with composing at an advanced work station with a large-screen monitor and mouse, as well as their interaction with a standard personal computer. Thus, as the research in composition in general has refined the methods borrowed from cognitive psychology, we are beginning to see this same sort of analysis with studies in computers and composition.

Although the results from these quantitative studies are many and varied, there are several common findings (See Table 1): students seem to have positive attitudes toward writing and word processing after working with computers; students exhibit finished products that have fewer mechanical errors than those written with traditional tools; and many students write longer pieces with word processing than with traditional methods. We find conflicting results when we examine two variables--revision and quality. As many quantitative studies found increased revision as found no increase in revision and as many found

improvement in quality as found no improvement. These findings suggest that writers' predispositions as revisers or non-revisers are more significant in predicting behavior than the influence of the machine and the ease with which writers can revise with word processing. Quality of writing, similarly, doesn't seem to be tied to computer usage--with some notable exceptions.

Of the 16 out of 18 experimental studies that examined quality, only eight found improvement. (All these studies employed trained raters and presented inter-rater reliability coefficients or percentages of agreement.) What's intriguing, however, is that of the four dealing with basic or developmental writers, all four reported improved writing with word processing in samples ranging from elementary (Burnett, 1984) to high school (Pivarnik, 1985; Cirello, 1986) to college (King, Birnbaum, Wageman, 1984). Some might argue that improvement for this group of writers has more to do with raters' positive responses to more pleasingly formatted texts than are usually submitted by basic writers. That is, raters might have scored the basic writers' texts higher than customarily because they didn't have to deal with unclear handwriting. But, if this were so, it would seem that other groups of writers would also be rated higher in the word processing condition, and this has not been the case. Moreover, of the four studies with basic writers reported here, the writing samples that were scored had been produced or reproduced on a computer. In other words, all drafts were of typed quality so any improvement raters might have judged as a

result of more pleasing copy was evident in pretest writing samples as well as in post tests.

Another more plausible explanation for the improved writing of basic writers is that word processing acts as a motivator, encouraging these students to spend more time and take more care with their writing than they do with conventional methods. If this is the case, the question then becomes one of how to maintain this high motivation as computers become increasingly commonplace. Will other types of software used in conjuntion with word processing, for example, add to the attraction of computers and continue to help basic writers improve their writing? Certainly, this group of writers bears further investigation at all academic levels.

Case Studies

When we look at the kinds of subjects examined in the case studies, differences appear in the targeted samples as well as in the focus of the research. Although some studies looked at elementary pupils, junior high students, and undergraduates, there is an additional emphasis on professional writers. In fact, four of the eleven pieces of research relying on case study methodology deal with published writers. In these, as in those case studies examining the educational setting, the major research questions asked were "How do writers adapt their strategies to computer writing?"; "Do writers' habits change with the technology?"; "How do writers regard writing with computers after working with them over a given period of time?"

A general theme emerging from these studies is similar to a conclusion drawn from the experimental research. That is, a writer's or student's particular habits and strategies for composing apparently take precedence over the machinery. While most writers adapt easily to a computer and find word processing an asset to their writing, they bring their routines and patterns of writing with them. If they weren't extensive revisers before word processing, they probably will not become extensive revisers as a result of learning word processing even when revision strategies are part of the instruction. Or, as Nichols (1986) points out in his case study of basic writers, "writers [use] the system mostly to do more of the same" of what they were doing with conventional methods (p. 90). And some don't even do more of the same. Although Bridwell, Sirc, and Brooke (1985) suggest that one of their subjects was interested in reformatting as a pencil and paper composer and expanded this interest as a computer composer, two of the undergraduates they studied seemed to use the system to avoid revising. That is, they interacted with their first drafts less intensely perhaps, printing out clean copy with few changes as final drafts.

One of the more intriguing hypotheses generated by the case study research is Catano's (1985) suggestion that the two novelists he studied used the computer to collect information and create meaning in such a way that word processing seemed to foster synthesis of their ideas. If, indeed, word processing can be used to help other writers, such as students, interact with their texts in ways that encourage higher order thinking skills,

we need to find out how. Seldom, however, are we able to study students intensely for a year, the length of time Catano observed the two novelists.

Several of the case studies reported here also analyzed writing products quantitatively (e.g., Bridwell, Johnson & Brehe, 1986; Bridwell, Sirc & Brooke, 1985; Collier, 1983; Daiute, 1984, 1985; Flinn, 1985; Harris, 1985; Lutz, 1983; Nichols, 1986; and Schipke, 1986). In general, their findings are congruent with the results of experimental research, i. e., texts tend to be longer with word processing and students' final products exhibit fewer mechanical errors. And, again, when revision and quality are examined the results are mixed. It should be noted, however, that far fewer of the qualitative studies tried to assess writing quality (e.g., Collier, 1983; Daiute, 1985, 1985; and Curtiss, 1984) and that, excepting Daiute's study, the judging of the writing was informal with no checks for reliability or rater agreement.

Ethnographic Studies

If case studies can be considered careful, naturalistic examinations of individuals, then ethnographies are their counterpart for examining a culture. The ethnographies presented here all deal with the culture of the school and classroom. Two of the studies looked at how elementary school students interact with a computer in a classroom context, and the other two examined students and computers in a high school setting. Some of David Dickinson's (1986) findings from a first and second grade combined class are provocative. While students did their

paper and pencil writing silently and privately at their desks, writing at a computer seemed to create a collaborative social organization in which there was considerable talk related to the writing. Moreover, the conversation among students seemed to focus on content and style whereas collaborate efforts with pen and paper often became bogged down in talk over handwriting. These studies of young children who have not yet developed writing strategies with pen and paper offer us a fresh perspective on how writers may use word processing when they are not trying to adapt old strategies to a new technology. Tammy Reid's (1985) ethnographic study of fourth graders also notes that computers seem to transform writing from a private to public activity. This theme corresponds to Billie Wahlstrom and Cynthia Selfe's (1986) observations of the kinds of interactions that occur among writers in a college computer writing lab. Andrea Herrmann's (1985) ethnographic study of high school students, on the other hand, seems to suggest that the presence of computers exacerbated differences among the eight students she studied in both their socioeconomic standing and their academic standing--certainly an important consideration. Can we, for example, find ways to reverse this potentially harmful influence by regarding it as a challenge rather than as a verdict? These ethnographies, then, often in elucidating the subtle influences of computers in social interactions among students and teachers, suggest the importance of the cultural context in shaping writers' work with word processing. The success or failure of students' encounters

with computers and writing might well depend on the context into which computers are introduced.

Some General Observations

Some general observations concerning both the quantitative and qualitative research reported here seem appropriate. When we look to the description of the context in which the research was conducted, there is often a decided lack of detail. Ironically, the quantitative studies seem to present a more complete description in this area perhaps because the instructional context was often regarded as part of the treatment and, therefore, in keeping with the conventions of empirical research, discussed in detail. The qualitative studies present rich detail in researchers' descriptions of their naturalistic observations and interviews but often fail to describe adequately the setting in which the writers worked.

Another flaw of a few of the studies is their failure to include and describe the word processing package. Only three of the studies omitted the specific computer and word processing software, but the majority didn't report the capabilities and perhaps idiosyncratic workings of the software. For example, the early *Bank Street Writer* (1982) forces writers to leave an insert mode in order to edit, certainly a maneuver which is antithetical to a recursive writing process. And *Wordstar* uses an abundance of control characters to perform operations and, in this respect, is decidedly different from other programs with their greater reliance on function keys. In addition, some programs facilitate the moving of text by allowing writers to highlight the targeted

segment and reinsert it someplace else very quickly; other programs, however, make this block movement of text tedious and cumbersome. The point here is that different programs might well facilitate some writing strategies to the exclusion of others, but we can't infer this without a description of the features of the word processing package.

A third general comment has to do with whether writers are composing at a computer or entering prewritten text. A great many more of the studies in this review seem to be focusing on writers composing at computers than in the past. Most would agree that to use a word processor as merely a transcription tool limits its capacity to influence composing processes. Moreover, *composing* at computers has come to mean a combination of hardcopy and screen-related activities. Bridwell, Sirc, and Brooke (1985), for example, in their case studies of undergraduates define computer composing as "whatever [the writers] did while they were working with the word processing systems, even though several of them continued to use paper for planning and some drafting." (p. 179) Some researchers (e.g., Lutz, 1983) mistakenly, I think, took pains to limit or prevent writers from printing out drafts during composing sessions, thinking that hard-copy was the province of pen and paper composing rather than computer composing. The longer we as writers and researchers work with computers, however, we come to realize that the screen often leads to reading difficulties and that intermittent printings of a draft allow us to compensate for having "screens-

full" rather than "pages-full" of text. (See chapters by Selfe and Haas, this volume, and Haas & Hayes, 1985.)

Recommendations

The foregoing review and discussion suggest several paths that researchers might follow in attempts to add to our accumulative knowledge in computers and composition:

1) Qualitative studies often provide rich description, revealing patterns and themes that can then be studied through quantitative methods. This is normally the way in which some perceive qualitative and quantitative research as intersecting. Seldom, however, do we see this relationship in research practice with computers and composition. For example, in their case studies of experienced writers, Bridwell and her colleagues (1986) observed writers devoting more time to pausing and planning than had been reported in other studies for writing in general. This prewriting or planning often took the form of writers pausing or jotting notes to themselves while they were writing at computers. These notes were sometimes metacomments, suggesting directions for organization and bearing scant resemblance to the final written products. Certainly, the way writers adapt this planning and note-jotting to computer writing bears further investigation. One wonders, for example, if these organizational prompts differ when writers compose at computers compared with conventional methods.

And, in fact, Christina Haas (1986) has begun to examine this phenomenon of planning on computers with the experienced writers she studied. Using think-aloud protocols, Haas focused on

planning as it occurred during revision and initial planning as it occurred before writers began writing. Haas found that the eight subjects she culled from her larger sample seemed to plan less in the personal computer and the advanced work station condition than with conventional methods of pen and paper. Ostensibly, this finding seems contradictory to Bridwell, Johnson, and Brehe's (1986) observations. Although Haas's experiment is small of scale and more of an attempt to replicate Gould's (1981) study than to experiment with some of the insights gleaned from an earlier qualitative study, it illustrates, I think, a pattern that could be followed as we establish our field of research. The point here is that studies should build upon one another--that as we conduct our research we must be aware of what has gone before us and how new research can confirm or contradict but nevertheless extend +our emerging knowledge base.

Let me further elaborate on this point. In the two studies discussed above, Bridwell and her colleagues were looking at planning as it manifests itself in written notes and pauses at the machine whereas Haas was concentrating on how this planning manifests itself in verbal protocols. Another investigation might examine how experienced word-processing writers use the bottom of their screens, or splitscreens that contain two or more files, or the special note options of some word processors--or, for that matter, hard copy for their interspersed planning. (See Hass's article, this volume, for a discussion of how some writers use hardcopy.) And, if experienced writers can indeed use these features effectively, then perhaps we want to introduce these

methods to students in instructional settings to examine how they integrate notetaking with computer composing. Some notetaking strategies might help students move back and forth between the conventions of standard printed text and the virtual text of a computer.

2. In writing of composition research in general, Hillocks (1986) discusses the need for a series of studies to examine a range of variables. Citing the work of Carl Bereiter, Marlene Scardamalia, and their colleagues at the Ontario Institute for Studies in Education (OISE) and Linda Flower, John Hayes, and their colleagues at Carnegie-Mellon University (CMU), he suggests that these researchers are noteworthy for their systematic research agendas. And, in fact, both OISE and CMU have contributed important studies for computers and composition as well. (See Woodruff et al., 1986; Haas, 1986; and Haas & Hayes, 1986 in Table 1.) Lillian Bridwell, Donald Ross, and their colleagues at the University of Minnesota have also been active in carrying out such research with word processing. (See Bridwell and her colleagues' studies in Table 2.) More recently at CMU, Christine Neuwirth, Christina Haas, and John Hayes have mapped out a series of seven studies with computers as part of a funded grant from the Fund for the Improvement of Postsecondary Education (FIPSE). The proposed studies (Neuwirth, Haas & Hayes, 1986) systematically explore three elements of the writing process: planning, revising, and reviewing. They are noteworthy, I think, in that each is prefaced with such statements as "If Study 1.1 obtains the expected results . . . we will then conduct

Study 1.2." (p. 10) In this way, each of the studies builds upon the previous and when completed should prove valuable to the field of computers and composition. As Hillocks suggests, more researchers need to engage in a series of studies designed to add to an emerging knowledge base.

3. A definite need also exists for longitudinal studies with writers and word processing. When one scans the research presented in Tables 1 and 2, it becomes apparent that the majority of studies took place over a relatively short duration of time. The longest study lasted for one full year (e.g., Catano, 1985), and several were conducted over an academic year (e.g., Daiute, 1986; Dickinson, 1986; Duling, 1985; Flinn, 1985; Herrmann, 1985; Levin et al., 1985; Pivarnik, 1985). But some were carried out over exceedingly short periods of time (e.g., Collier, 1983; Daiute, 1984, 1985; Miller, 1984; Nichols, 1986; Woodruff et al., 1986; Wooley, 1985) ranging from one to six weeks. And one (e.g., Harris, 1985) didn't report the duration of the study. Since most of these studies were also concerned with how the computer interacted with the writing processes of inexperienced computer users, one wonders how much of the influence of word processing was captured over these short periods. New research might be directed, instead, to examining inexperienced word processors as first-year college students and look at them over a period of four years. This sort of longitudinal approach might suggest emerging patterns of composing that we have as yet not observed.

4. Another recommendation would be to do more studies of writers that use word processing all the time for their composing. Six years ago few writers could perhaps be so categorized, but today we have burgeoning numbers of computer composers. Rae Schipke (1986) in her research of a free-lance science writer and a speech writer adds considerably to Catano's (1985) study of experienced writers but nevertheless amateur word processors. Schipke notes that the ways these experienced writers used word processing varied considerably with the knowledge they possessed over their topic. Additional studies might shed light on whether word processing does indeed contribute to stimulating creative thought as the professional writers in Catano's study suggest.

5. For the instructional context, we need to examine how computers interact with the activities of the classroom. Preliminary evidence (Selfe & Wahlstrom, 1986; Dickinson, 1986) suggests that computers foster collaboration among writers, transforming the process of writing from a private to a public act (Reid, 1985) both with young students and adults. These initial studies have been surveys or qualitative investigations. Another way of approaching this question might be to compare classroom activities that occur in process-centered, computer-equipped classrooms with activities in process-centered, conventional classrooms. During classroom observations, researchers would code activities, using similar categories as those outlined by Arthur Applebee (1981) in his description of writing in secondary schools. Applebee, for example, lists

writing without composing, as well as informational, personal, and imaginative uses of writing as types of writing activities that might occur in a classroom. Added to this list might be other precisely defined categories to describe the amount of time each class period devotes to teacher presentation, student presentation, group work (with and without computers), and writing (with and without computers). These data would then be analyzed to determine similarities and differences in several composition classes taught with and without computers. The types of work assigned outside of class would also be examined. Such an approach would allow us to assess the kinds of collaboration that occur among students and teachers, as well as to determine the types of learning activities that instructors tend to rely on in computer-assisted and conventional writing classes.

6. The advantages of using the computer as a research tool has been noted elsewhere (Bridwell, Johnson & Brehe, 1986). For the first time we have a tool with an enormous memory for recording writers' generating and revising of text. Using public domain macro software at Illinois State University, we have developed a keystroke-monitoring program which captures all keystrokes writers make in a given session, thus providing a record of their composing and revising. Lutz (1983) and Flinn (1985) also report using keystroke-capturing programs for their research. A sophisticated program developed by the University of Minnesota team seems especially promising. In addition to capturing keystrokes, it offers a built-in record of the time writers spend in composing as well as in pausing. It also allows

for a playback of text that researchers can then use for retrospective protocols, i. e., writers describe what they were thinking as their text scrolls before them at the same rate of speed with which they produced it. (See Bridwell, Nancarrow & Ross, 1984 for a more complete description of the program.) Given the seeming advantages of such records, it is surprising that we don't see more research conducted with these programs.

One of the problems, I think, is that while keystroke programs enable computers to collect enormous amounts of data, these data must still be analyzed by human beings. One paragraph with all its revisions often yields a full page or more of data, and these data seem to increase exponentially with several drafts of a paper. Thus, a three-page, double-spaced draft might well yield 10 pages of data which then must be compared with the writer's actual text to understand what was generated and revised. The keystroke print-out alone is undecipherable in terms of seeing change in relation to the writer's text. Thus, although we now have the technology to help with in-process revision data collection, we still lack an expedient tool to aid in analysis.

More time and energy should be spent in developing programs that are easily decipherable by trained text analysts. We envision a program that prints the real text in one column with the changes in a second column, at least allowing a ready scanning and comparison of keystroke print-out and text. The computer could also be programmed to record changes that involve larger segments of text along with appropriate function keys, rather than concentrating on individual keystrokes. We have

learned through our research that although writers seem to make more typographical errors initially (Bridwell, Sirc, and Brooke, 1985), they quickly correct them and final texts tend to exhibit fewer surface errors with word processing (Daiute, 1986; Duling, 1985; Levin et al.,1985; Woodruff et al., 1986). Therefore, we might concentrate on developing programs that focus on chunks of text since larger revised segments often contain meaningful changes, which seem to be characteristic of good writers (Faigley & Witte, 1981, 1984). Although the development of additional research programs requires careful planning between researchers and programmers, the time devoted to this endeavor would be well spent in facilitating our research efforts. Ideally, of course, it would be helpful if technology could also be enlisted to analyze some of the changes, but this eventuality still seems distant in terms of a computer's current capability to process natural language. In any event, we need to develop computers as research tools. We have only begun to tap the potential of technology and its possible contribution to research.

Conclusion

What have we learned from our research of the past six years? And, is it, as Papert suggests of computer research in general, technocentric? Perhaps--but we are also slowly but surely building a research base that relies less on a technocentric perspective than on a view informed by the interaction of technology with the culture in which it exists. Even though a review of the titles of some of the more recent studies reveals still a technocentric emphasis, the research

itself often considers context in the quantitative studies, as well as in the qualitative. Moreover, several of the studies, such as those by Woodruff (1986) and his colleagues, are asking complex questions such as how does cognitive development in students interact and affect their use with computers. Notice the emphasis here is on *students* rather than on *computers*. And, it is worth remembering, I think, that most of the studies cited here were begun an average of three or more years ago. None of these studies, for example, looked at writers interacting with the Macintosh with its icon system and highly developed graphic capabilities.

When I examined 24 studies in computers and writing last year (See Hawisher, 1986) few of the patterns noted here were evident. Instead the results seemed to be confusing and contradictory--as they still are to a great extent today. But in the past year there has been a coming together of findings that begin to form a research base, i.e., students seem to have a positive attitude toward writing with computers and seem to write longer texts that exhibit fewer mechanical errors. Thomas Kuhn (1970), whom both James Kinneavy (1980) and Maxine Hairston (1982) cited some years ago in describing the preparadigm stage of rhetoric and composition, also has something to say, I think, that applies to our research in computers and composition. Kuhn notes that when a field is establishing itself, its research is inconclusive and that the same ground is covered repeatedly. Studies in word processing are only now emerging from this preparadigm stage of development. It will be interesting to see

how we pursue our research in computers and composition during the next several years. As Papert (1987) has suggested for computer research and as Alan Purves (1986) has argued in discussing the study of writing in general, we must give culture--along with technology--its due.

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Table 1

Experimental Studies

• information not given
X examined
– not a concern of study

STUDY	SAMPLE	NUMBER	DURATION: weeks	WORD PROCESSING PACKAGE	COMPUTER	SETTING	DESIGN: Description of Instruction	# instructors	Computer/Writer attitudes	Errors	Quality	Syntax	Processes	Revision	# words	Time	Cognitive Development	Assessment	ANALYSIS: Revision	Interview	Syntactic	Keystroke	Surveys	Protocols	Journals	Other	Positive attitudes	Results @ Computer: Fewer Errors	Improved Quality	Increased Revision	Increased Fluency	Increased Length	Increased Time	NOTEWORTHY
Burnett (1984)	Low Achievers 1st-5th Graders	10	8	Bank Street Writer (BSW) 1982	Apple IIe	Reading Group within Class	Process-centered	•	Y	X	–	X	X	–	–	–	–	–	Holistic (H) Analytic (A)	–	X	–	–	–	–	–	–	Y	–	Y	–	Y	–	–	Experiment replicated nine times with different students
Cirello (1986)	10th grade basic writers	30	20	BSW 1982	Apple	English Class with Computers	Process without Peer Review	1	Y	–	–	X	X	–	–	X	–	–	Holistic	researcher criteria	–	X	–	X		X	–	–	–	N/Y	Y	Y	Y	–	Students' writing significantly improved on two of the timed writing tasks
Coulter (1986)	College first-year	62	16	•	•	Computer LAB	•	6	Y	–	–	X	–	–	X	–	X	X	Holistic	Bridwell (1979)	–	–	–	–	–	–	X	–	–	N	N	–	–	–	Amount of time spent in writing with wp should no significant correlation with writing quality, revision type, or syntax
Daiute (1986)	4th, 5th Graders	57	36	CATCH	Apple II Plus	Writing Classroom	Process-centered Workshop	1	Y/N	–	X	X	–	–	X	X	–	–	Holistic	Faigley & Witte	–	–	–	–	–	–	X	–	Y	N/Y	–	–	–	–	-also looked at effect of computer prompt for "Revision"
Duling (1985)	4th Graders	20	36	Simpsit — StoryWriter	TRS 80 — PET	English Class with Computers	English Curriculum of literature + writing	1	N	–	X	X	X	–	X	X	–	–	Holistic	Bridwell (1979)	–	–	–	–	–	–	–	Y	N	N	–	N	–	All first drafts written by hand
Gould (1981)	IBM Researchers	10	–	EDIT REDIT	IBM mainframe	Workstation	–	–	Y	–	–	X	–	X	X	X	X	–	Holistic	Video-tapes	–	–	Y	–	–	–	–	–	N	Y	–	Y	Y	The word processor was a time saver than a thesaurus or editor
Haas (1987)	Experienced Academics	15 8	–	EMACS + mouse MINCE	"dumb" main-frame	Workstation	–	–	Y	–	–	–	–	X	X	–	–	–	–	Protocols	X	–	–	–	X	–	–	–	–	–	–	–	–	–	– looked at planning and rereading; less planning in computer condition
Haas & Hayes (1986)	Experienced Academics	15	–	EMACS + mouse MINCE	"smart" main-frame	Workstation	–	–	Y	–	–	X	–	–	–	X	X	–	Analytic	–	–	–	–	–	–	–	–	–	–	Y/N	–	–	Y	Y	"Quality judged highest when writing produced at workstation with larger screen
Hawisher (1986)	College first-Year	20	16	Volkswriter	IBM	Writing Class with Computers	Process without Peer Review	1	Y/N	X	–	X	–	X	X	–	–	–	Analytic	Faigley & Witte	–	–	–	–	–	X	–	Y	–	N	–	–	–	–	Same students write four essays with and without computers
Kaplan (1986)	5th Graders	56	5	SELECT	DEC Rainbow	Classroom Lab	Conference Process Approach	2	Y	–	–	X	–	–	X	X	–	–	Holistic	Faigley & Witte	–	–	–	–	–	–	–	–	Y	N	–	Y	–	Experimental group wrote longer and better pieces in a revision-centered instructional environment with word processing
King, Birnbaum & Wageman (1984)	College basic writers	10	16	BSW 1982	Apple IIe	Tutorial Sessions	Remedial Tutoring	1	Y/N	X	–	X	–	–	X	–	–	–	Analytic	Checklist	X	–	–	X	–	X	–	Y	–	Y	–	Y	–	All female students
Levin, Riel, Rowe, & Boruta (1985)	6th Graders	10	36	Writer's Assistant	Apple	Classroom	Process-oriented	1	•	X	X	–	–	–	X	X	–	–	–	–	X	–	–	X	–	–	–	Y	Y	–	–	–	N	–	Students made and corrected more surface errors with word processing.
	Survey	30																																	
Miller (1984)	6th Graders	28	5	BSW 1982	Apple IIe	Computer LAB	•	2	N	X	–	X	–	–	–	X	–	–	Holistic	–	–	–	–	X	–	–	–	–	–	N	–	–	N	–	All first drafts written by HAND
Pivarnik (1985)	11th grade basic writers	76	36	Word-Star	TRS 80	•	Process-oriented	1	Y	–	–	X	–	–	–	–	–	–	Holistic	–	–	–	–	–	–	–	–	–	Y	–	–	–	–	A second Writing Sample supported initial Results
Sommers (1986)	College Students	79	16	BSW Homework Apple Writer	Apple	College Writing Classrooms	Process-Oriented	6	Y/N	X	–	X	–	X	X	–	X	–	Holistic	Faigley & Witte	–	–	–	–	–	–	–	Y	–	Y	Y	–	–	Y	Four students' writing was the focus of the Revision Analysis
	Survey	31																																	
Wetzel (1985)	3rd, 4th and 5th Graders	36	10	BSW 1984	Apple	Computer LAB	Teacher followed researcher's scripts	8	Y	–	–	X	–	–	–	–	–	–	Holistic	–	–	–	–	–	–	–	–	–	N	–	–	–	–	Researcher found a significant positive correlation between typing speed and quality of student writing.
Woodruff, Lindsay, Bryson, & Joram (1986)	Average and Remedial 8th Graders	16	1	Icon Driven Word Processor	Icon	•	–	•	Y	X	X	X	X	X	X	X	X	X	Holistic	•	X	X	–	X	X	–	X	Y/N	Y	N/Y	–	–	Y	Y	This study focuses on how students' cognitive ability affects their use of word processing.
Woolley (1985)	5th Graders	20	2	BSW	Apple	Classroom	Process-Oriented	2	Y	–	–	X	–	–	–	–	–	–	Holistic + Analytic	–	–	–	–	Y	–	–	–	–	–	N	–	–	–	–	students in the experimental group wrote at computers for 16 45-minute periods

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Table 2
Case Studies and Ethnographies

– not a concern of study
• information not given
X examined

STUDIES	DESIGN			TOOLS		CONTEXT			ANALYSIS											THEMES
CASE STUDIES	Sample	Number	Duration: # weeks	Word processing package	Computer	Setting	Number of Instructors	Description of Instruction	Composed with computers/ written product analysis	Interview	Keystroke	Assessment	Survey	Revision	Protocols	Journals	Observation	Video/audio tapes	
Bridwell, Johnson & Brehe (in press)	Published Graduate Students	8	10	Word-Star	IBM	Working at Computers/LAB	–	–	Y/N	X	X	X	–	–	–	X	–	X	X	Researchers identified three kinds of writers whose adaptation to computer composing varied with their skills. Writers produced longer texts finally.
Bridwell, Sirc & Brooke (1985)	College Students / Survey	5 / 48	10	Word-Star	IBM	Working at Computers/LAB	1	Business Writing Class	Y	X	X	X	–	X	Brownell (1979)	X	–	–	X	Writer, computer, and task all interrelate in determining how word processing will be used by individuals.
Catano (1985)	Novelists	2	52	Brown University Package	main-frame IBM	Working at Computers/LAB	–	–	Y	–	X	–	–	–	–	–	–	X	–	Writers reported that word processing seemed to facilitate their collection of information and to stimulate creativity
Collier (1982, 1983)	Nursing Students	4	6	AES	AES-C20	Classroom; also Computer LAB	1	•	N	X	X	–	X	–	Collins (1982)	X	–	–	X	Although students seemed to revise more frequently, they did not revise more successfully.
Daiute (1984, 1985)	9-12 Year-olds / Observation	2 / 8	5	CATCH	APPLE II PLUS	•	•	•	Y	X	X	–	Haas-Hayes	–	Eight-Wide	–	–	X	–	After using CATCH, a word processing program with revision prompts, most students revised more and corrected more errors. Few however, produced texts that were rated higher.
Flinn (1985)	6th Graders	8	36	Milliken Word Processor	APPLE II e	Classroom with Computers	4	National Writing Project Classes	Y	X	X	X	–	–	Bridwell (1976)	X	X	X	X	Children revised larger chunks of text at computers; pen and paper writers focused instead on surface features.
Harris (1985)	College Students	6	•	•	•	Writing Center or Microcomputer Lab	•	•	N	X	X	–	–	–	Eight-Wide	–	X	X	–	Fewer macrostructure changes were made with computers. It should be noted that 1st drafts not necessarily written on computer
Lutz (1983)	Professional or Experienced Writers	7	–	MTS	main-frame	•	–	–	Y	X	X	X	–	–	Eight-Wide	–	–	X	X	Both Professionals and experienced writers made many more revisions at computers.
Nichols (1986)	College Basic Writers	5	7-10 days	BSW 1982	APPLE II e	Private room in library for computers	1	During study writers received no composition instruction.	Y	X	X	–	–	–	X	X	–	–	–	Writers used the system to do more of the same of what they were doing without word processing. Judgments were...
Schipke (1986)	Professional Writers	2	12 hrs over many months	Scripsit / OASYS 64	TRS 80 / NBI	HOME / office	–	–	Y	X	X	–	–	–	X	X	X	X	–	Word processing helped professional writers carry out their established practices and routines with greater efficiency.
Selfe (1985)	College Students / Observation / Survey	2 / 8 / 51	16	•	•	COMPUTER LAB	–	–	Y/N	–	–	–	–	X	–	X	–	X	X	Individuals' attitudes toward word processing and the ease with which they could adapt their writing habits to computers determined how they used WP.
ETHNOGRAPHIES																				
Curtiss (1984)	HIGH SCHOOL SENIORS	53	18	BSW 1982/ AppleWriter	APPLE II e	COMPUTER LAB CLASSROOM	1	Process-Centered	Y/N	X	X	–	X	X	X	–	X	X	–	51 of the 53 students came to value word processing as a tool for creating QUALITY WRITING.
Dickinson (1986)	1st and 2nd Graders	21	32	•	APPLE II e	Classroom with ONE COMPUTER	1	Process-Centered	Y	–	X	–	–	–	–	–	X	X	X	Talk between students at computer more likely to focus on style and content, often on production of acceptable handwritten text, a common concern for these students without computers.
Herrmann (1985)	HIGH SCHOOL STUDENTS	8	36	BSW 1982	APPLE II PLUS	Classroom with Computers	1	Process-Centered	Y/N	X	X	–	–	–	X	–	X	X	X	Computers seemed to reinforce differences in both socioeconomic and academic standing that already existed among students.
Reid (1985)	4th Graders	class / 4	28	Milliken's Writing Workshop	Apple II C's & E's	Classroom, HALL, and LAB	1	2 DAYS of Writing per Week	Y	X	X	–	–	X	–	–	–	X	X	Computer seems to act as catalyst in transforming writing from a private to public activity.

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